

EXECUTIVE SUMMARY

To date, seventeen sites within the Canal Creek Study Area (CCSA) of Aberdeen Proving Ground (APG), Maryland, have been closed out under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Records of Decision (RODs). Approximately thirty-nine sites remain open under on-going CERCLA investigations. The four largest of the remaining sites are being addressed under individual Remedial Investigation/Feasibility Study (RI/FS) tasks: EACC1K – Canal Creek Marsh and Landfill, EACC4A-B – West Canal Creek Area – Canal Creek Aquifer (CCA), EACC5A – Canal Creek Sediments, and EACC5B – Kings Creek Sediments. This draft Remedial Investigation (RI) report is the last installment of four volumes that will address the thirty-five remaining CCSA soils sites. For the purposes of the risk assessments and RI, these sites have been divided into four regions (Figure ES-1). This volume presents the site background, technical approach, and results of environmental investigations completed for the fifteen sites within the Kings Creek Industrial Area (KCIA):

- EACC3A – Building E3330 Laboratory Toxic Waste Disposal Pits
- EACC3C – Building E32XX, E3100, E3081 Medical Research Laboratories
- EACC3D – Building E3160 Complex
- EACC3E – Building E3300 Laboratory Complex
- EACC3F – Building E35XX Area
- EACC3G – Building E360X, E361X, E362X Area
- EACC3I – Building E3570 Assembly Plant
- EACC3J – Building E3580 Pyrotechnic Loading Facility
- EACC3K-A – Building E3700 Complex
- EACC3K-B – B-Field Kings Creek Dump Site
- EACC3L – Building E3640 Process Laboratory
- EACC3M-A – Wastewater Treatment Plant
- EACC3N – Beach Point Test Site
- EACC3O – B-Field Range
- EACC3P – Mosquito Test Grid Area

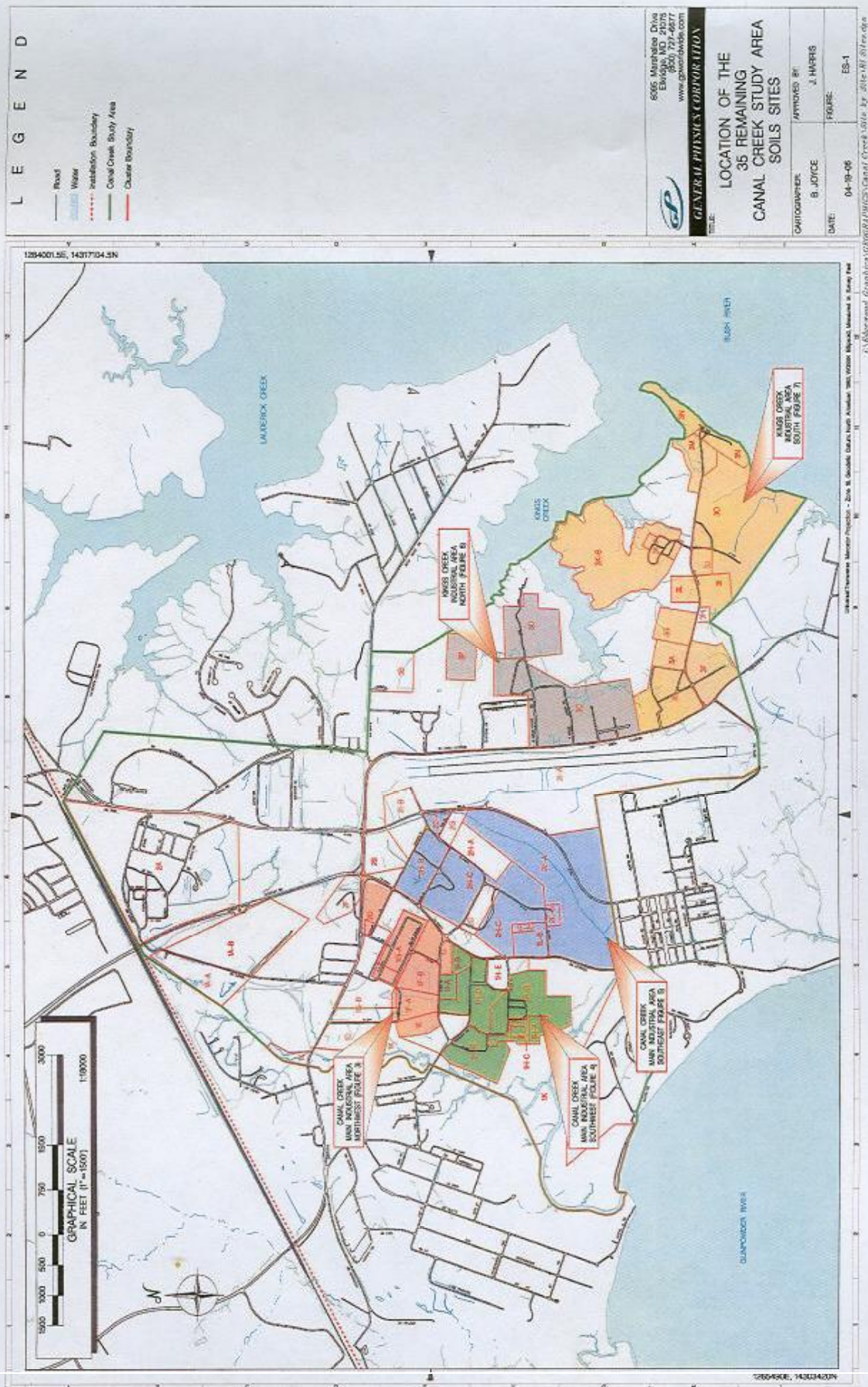
These sites include former research and development areas, medical laboratories, fabrication/assembly facilities, test sites, and suspected disposal areas. Current and future land

use is industrial. The three other regions of the CCSA were addressed in separate RI volumes (to be consistent with the risk assessment documents and to facilitate the stakeholder review process). Later, the four draft reports will be combined and published as one final RI document.

Over the past ten years, significant soil and sediment sampling has been conducted throughout the CCSA. Within the KCIA Region, arsenic, lead, mercury, dieldrin, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) were the only chemicals detected in excess of US Environmental Protection Agency (USEPA) Industrial Soil Risk-Based Concentrations (RBCs). Arsenic concentrations were detected above industrial soil RBCs at all fifteen of the KCIA sites in surface and subsurface soil. During Phase I sampling at three of the sites (EACC3C, EACC3K-A, and EACC3N) the PAH compound benzo[a]pyrene was detected above industrial soil RBCs. Site EACC3C also had detections of benzo[a]anthracene and dibenz[a,h]anthracene above industrial soil RBCs. These compounds were detected during later rounds of RI sampling, but at much lower concentrations. The pesticide dieldrin was detected above the industrial soil RBC and BTAG screening level at EACC3L during Phase I sampling. Dieldrin was not detected in Phase II sampling at EACC3L, but it was detected during Phase III at much lower concentrations. The highest concentrations of PCBs were also detected at site EACC3L during Phases I and II.

Lead was detected above the USEPA lead guidance value for industrial soil, the Biological Technical Assistance Group (BTAG) screening level, and reference background at site EACC3C during Phase I and Phase II sampling. The concentration was higher in the Phase II sample. Mercury was detected above the USEPA mercury guidance value for industrial soil, the BTAG screening level, and reference background at site EACC3C during Phase I and Phase II sampling. The concentration was higher in the Phase II sample. Other metals and organic compounds exceeded background (either naturally-occurring or established anthropogenic values) and/or BTAG screening levels, but were below industrial soil RBCs.

Metal-, PAH-, pesticide- and PCB-contamination tends to be fairly localized at the CCSA KCIA sites because these chemicals bind strongly to soil rather than leaching into groundwater. Arsenic has been detected consistently throughout the KCIA sites in surface and subsurface soil. The transport of arsenic compounds is generally due to erosion of particles, including soil, and sediment containing clays, iron oxides, aluminum hydroxides, manganese compounds, and organic material with sorbed arsenic. Most PAHs occur naturally and tend to be persistent in the environment. Pesticides are typically persistent in the environment and degrade slowly. Locations of pesticide detections in soil/sediment are typical of point sources and not likely due to historical activities other than grounds maintenance. PCB compounds (e.g., Aroclor 1248 and Aroclor 1260) demonstrate strong absorption to soil and sediment media indicating that significant leaching to groundwater should not occur. However, PCB compounds may leach into



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groundwater when combined with organic solvents which demonstrate significant leaching capabilities.

Nine of the fifteen KCIA sites were combined into three groups for evaluation in the Human Health Risk Assessment (HHRA) based on similarity in site contaminants and proximity. Sites EACC3C, EACC3D, and EACC3P were grouped as Kings Creek North. Sites EACC3M-A, EACC3N, and EACC3O were grouped as Kings Creek Peninsula. Sites EACC3F, EACC3I, and EACC3J were grouped as Kings Creek South. The remaining six sites (EACC3A, EACC3E, EACC3G, EACC3K-A, EACC3K-B, and EACC3L) were assessed individually. Based on the results of the HHRA, the three grouped sites do not exceed target risk levels for any of the industrial receptors. Blood-level lead modeling for the North Kings Creek Group indicates no concern for any receptor at the site; however, the presence of lead above the USEPA's industrial guidance level of 1,000 milligrams per kilogram (mg/kg) should be noted, should residential use occur in the future. Calculated risks for all industrial and residential receptors at EACC3L are above the acceptable risk range due to mercury, dieldrin, and PCBs. Lead in surface and total soil does not pose a concern for this site. The KCIA sites are not currently used for residential purposes; however, the residential scenario was evaluated for planning purposes to determine if land-use controls would be required. Non-carcinogenic risks to the hypothetical future child (evaluated for planning purposes only) have been identified for site EACC3A and the Kings Creek Peninsula Grouping (EACC3M-A, EACC3N, and EACC3O), driven primarily by mercury. Sample 3A-SS-04 at site EACC3A was considered a hot spot based on elevated concentrations of arsenic, chromium, 4,4-dichlorodiphenyltrichloroethane (DDT), and Aroclor 1248; thus, data from this location was not assessed with the remainder of the data for site EACC3A. The calculated risks for all industrial and residential receptors are within or below the established risk thresholds for sites EACC3E, EACC3G, EACC3K-A, and EACC3K-B.

Based on the information gathered during Steps 1 through 7 of the Ecological Risk Assessment (ERA), further evaluation of potential risks to ecological receptors is not warranted at sites EACC3F, EACC3I, EACC3M-A, or EACC3O because no chemicals were maintained as ecological COCs. At site EACC3A, there is potential for risks to terrestrial plants (from mercury and methyl mercury), soil invertebrates and vermivorous mammals (from mercury, methyl mercury, and Aroclor 1248), herbivores and predatory mammals (from methyl mercury), and vermivorous birds (from mercury, methyl mercury, Aroclor 1248, and DDT). Site EACC3C poses potential for risks to terrestrial plants and soil invertebrates (from mercury, methyl mercury, and zinc) and vermivorous birds (from lead, methyl mercury, and DDT). Calcium was maintained as a contaminant of potential concern (COPC) to vermivorous mammals and birds; however, the true potential for risk is unlikely because calcium is an essential nutrient. At site EACC3D, there is potential for risks to terrestrial plants (from zinc), soil invertebrates and vermivorous mammals (from thallium), benthic organisms (from mercury

and silver), and vermivorous birds (from DDT_r). At site EACC3E, there is potential for risks to terrestrial plants (from zinc) and vermivorous birds (from DDT_r). Site EACC3G poses potential risk to terrestrial plants (from zinc) and vermivorous birds (from DDT_r). Site EACC3J poses potential risk to terrestrial plants and soil invertebrates (from 2,4,5-T). At site EACC3K-A, there is potential for risks to terrestrial plants (from zinc) and to vermivorous birds (from DDT_r). At site EACC3K-B, there is potential for risks to benthic organisms (from copper and carbon sulfide) and to vermivorous birds (from DDT_r). Site EACC3L poses potential risk to soil invertebrates (from mercury, methyl mercury, silver, Aroclor 1248, Aroclor 1254, and Aroclor 1260); to herbivores (from methyl mercury and Aroclor 1248); to vermivorous mammals (from mercury, methyl mercury, Aroclor 1248, and Aroclor 1254); to vermivorous birds (from mercury, methyl mercury, and Aroclor 1248); and to predatory mammals (from methyl mercury and Aroclor 1248). At site EACC3N, there is potential for risks to terrestrial plants (from mercury, methyl mercury, silver, and zinc) and to soil invertebrates (from mercury and methyl mercury). Silver was maintained as COPC for soil invertebrates due to mixed correlation results. Methyl mercury was maintained as a COC for herbivores, vermivorous mammals, vermivorous birds, and predatory mammals; although the potential for risks is considered overestimated based on the highly conservative assumption that 100% of mercury exists as methyl mercury. The pesticide DDT and related compounds (DDT_r) were maintained as COCs for vermivorous birds, but most concentrations of DDT_r were below reference Upper Prediction Limits (UPLs) and all concentrations were within the range of ubiquitous concentrations at APG. Site EACC3P poses risk to soil invertebrates (from mercury and methyl mercury), although the potential for population-level effects is considered low because only one sample had a concentration greater than reference.

There is uncertainty regarding the potential for risks from exposure to metals at sites EACC3F, EACC3I, EACC3J, and EACC3M-A, because metals were not validated, and therefore were not included quantitatively in the risk assessment. However, metals were evaluated with respect to screening-level concentrations and reference data in order to determine whether or not addressing this data gap was warranted (EA, 2006h). Potential for risks to amphibians at site EACC3O is uncertain. Risk management decisions (i.e., ERA Step 8) for these sites will be made upon finalization of Steps 1 through 7 for the other three regions of the CCSA. Although there is potential for risk based on the USEPA's 7-Step ERA process, field tests that demonstrate actual risk to reproduction (e.g., rodent sperm analysis) have not been performed.

Based on the RI data screening and results of the HHRA and ERA, the following sites are recommended for evaluation in the draft *Feasibility Study for the Thirty-Five Remaining Soils Sites* (anticipated in FY07): EACC3A (Building E3330 Laboratory Toxic Waste Disposal Pits), EACC3C (Building E32XX, E3100, E3081 Medical Research Laboratories), EACC3D (Building E3160), EACC3E (Building E3300 Laboratory Complex), EACC3G (Building E360X, E361X,

E362X Area), EACC3J (Building E3580 Pyrotechnic Loading Facility), EACC3K-A (Building E3700 Complex), EACC3K-B (B-Field Kings Creek Dump Site), EACC3L (Building E3640 Process Laboratory), EACC3N (Beach Point Test Site), and EACC3P (Mosquito Test Grid Area). Sites EACC3J and EACC3P were carried forward to the FS stage (consistent with CERCLA guidance); however, these sites may only require monitoring or land-use controls because there is no potential risk to higher level ecological receptors. Aside from land-use controls, no further evaluation or engineering measures are recommended for sites EACC3F (Building E35XX Area), EACC3I (Building E360X, E361X, E362X Area), EACC3M-A (Wastewater Treatment Plant), and EACC3O (B-Field Range).

Due to the nature of historical activities within the Edgewood Area of APG, UXO and white phosphorus may be present at the KCIA sites. Therefore, existing Installation safety policies and procedures will be followed for any soil disturbances in the future. These precautions will be taken to ensure adequate protection of workers, military personnel, and nearby residents in military housing. For these same reasons, land-use controls will be implemented to prevent future residential land use within the fifteen KCIA sites. The Proposed Plan and ROD documents for these sites are anticipated in FY08/FY09.

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1.0 INTRODUCTION

The U.S. Army Garrison Aberdeen Proving Ground (APG), Directorate of Safety, Health and Environment (DSHE) tasked General Physics Corporation (GP) with investigation of thirty-five sites within the Canal Creek Study Area (CCSA). This project is being conducted in support of the APG Installation Restoration Program (IRP) under Contract Number DAAD05-97-D-7003, Delivery Order 0222.

This Remedial Investigation (RI) is part of the CCSA-wide "Potential Source Definition Study", which is intended to identify and address potential sources that may be contributing to groundwater contamination at CCSA. Groundwater contamination within the West Canal Creek Area (WCCA) is being addressed under a separate Draft Final RI (Weston, 2005). Groundwater contamination within the East Canal Creek Area (ECCA) is currently being captured and treated at the Canal Creek Groundwater Treatment Plant, in accordance with the Record of Decision (ROD) signed in July 2000 (Weston, 2000a).

1.1 Purpose and Scope

To facilitate investigation of the CCSA, over fifty Army Environmental Database – Restoration (AEDB-R) Site Numbers [also commonly referred to as Defense Site Environmental Restoration Tracking System (DSERTS) Numbers] have been assigned. These sites are identified with an alphanumeric site identification number, including "EACC" for Edgewood Area - Canal Creek and cluster number and letter designation (e.g., EACC2A).

To date, seventeen CCSA sites have been closed out (or are pending closure) under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RODs. Approximately thirty-nine sites remain open under on-going CERCLA investigations. The four largest sites are being addressed under individual Remedial Investigation/Feasibility Study (RI/FS) tasks: EACC1K – Canal Creek Marsh and Landfill, EACC4A-B – West Canal Creek Area – Canal Creek Aquifer (CCA), EACC5A – Canal Creek Sediments, and EACC5B – Kings Creek Sediments. The thirty-five remaining "soils sites" have been divided into the following regions:

Canal Creek Main Industrial Area – Northwest (MIA-NW)

- EACC1E – Building 87 Complex
- EACC1F-A – Building E5604
- EACC1F-B – Former Building 80 Series Smoke Laboratory
- EACC1G-A – Building E5185 World War II (WWII) Mustard Plant

- EACC1J – Building 30 Toxic Waste Disposal Pits
- EACC2D – Laboratory Toxic Waste Disposal Pits

Canal Creek Main Industrial Area – Southwest (MIA-SW)

- EACC1H-A – 1937 Mustard Disposal Pit
- EACC1H-B – WWII Chlorine Plant
- EACC1H-C – Building E5483 Protective Clothing Laundry
- EACC1H-D – Phosgene Plant Area
- EACC1H-F – Experimental Chemical Plants
- EACC1H-G – Mustard Plant Area
- EACC1I-A – Building 106/107
- EACC1I-B – Building 113 World War I (WWI) Gas Instruction Chamber

Canal Creek Main Industrial Area – East (MIA-E)

- EACC1L-A – Building 503 Smoke Mixture Burning Areas
- EACC1L-B – Building 503 (E5265) Smoke Pot Plant
- EACC2E-A – Canal Creek East Branch Landfill
- EACC2E-B – Noble Road Incinerators (Buildings E5292 and E5294)
- EACC2H-B – WWI Shell Dumps including Buildings E5158, E5165, E5179
- EACC2H-C – Filling Plants #1 and #2

Kings Creek Industrial Area (KCIA)

- EACC3A – Building E3330 Laboratory Toxic Waste Disposal Pits
- EACC3C – Building E32XX, E3100, E3081 Medical Research Laboratories
- EACC3D – Building E3160 Complex
- EACC3E – Building E3300 Laboratory Complex
- EACC3F – Building E35XX Area
- EACC3G – Building E360X, E361X, E362X Area
- EACC3I – Building E3570 Assembly Plant

- EACC3J – Building E3580 Pyrotechnic Loading Facility
- EACC3K-A – Building E3700 Complex
- EACC3K-B – B-Field Kings Creek Dump Site
- EACC3L – Building E3640 Process Laboratory
- EACC3M-A – Wastewater Treatment Plant
- EACC3N – Beach Point Test Site
- EACC3O – B-Field Range
- EACC3P – Mosquito Test Grid Area

This Volume of the RI Report presents the site background, technical approach, and results of environmental investigations completed for the fifteen sites in the KCIA Region. The three other regions of the CCSA will be addressed in separate draft RI volumes (to be consistent with the risk assessment documents and to facilitate the stakeholder review process). Later, the four draft reports will be combined and published as one final reference document.

The DSHE Environmental Conservation and Restoration Division (ECD), manager of the APG IRP, conducted the RI/FS under the direction of the US Environmental Protection Agency (USEPA) Region III and the Maryland Department of the Environment (MDE), following the terms of the Federal Facility Agreement (FFA) signed on March 27, 1990 (USEPA Region III et al, 1990).

1.2 Report Organization

This RI report is organized into the following eight sections:

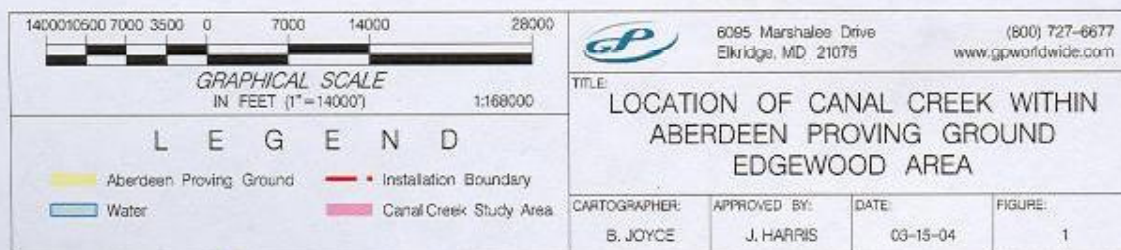
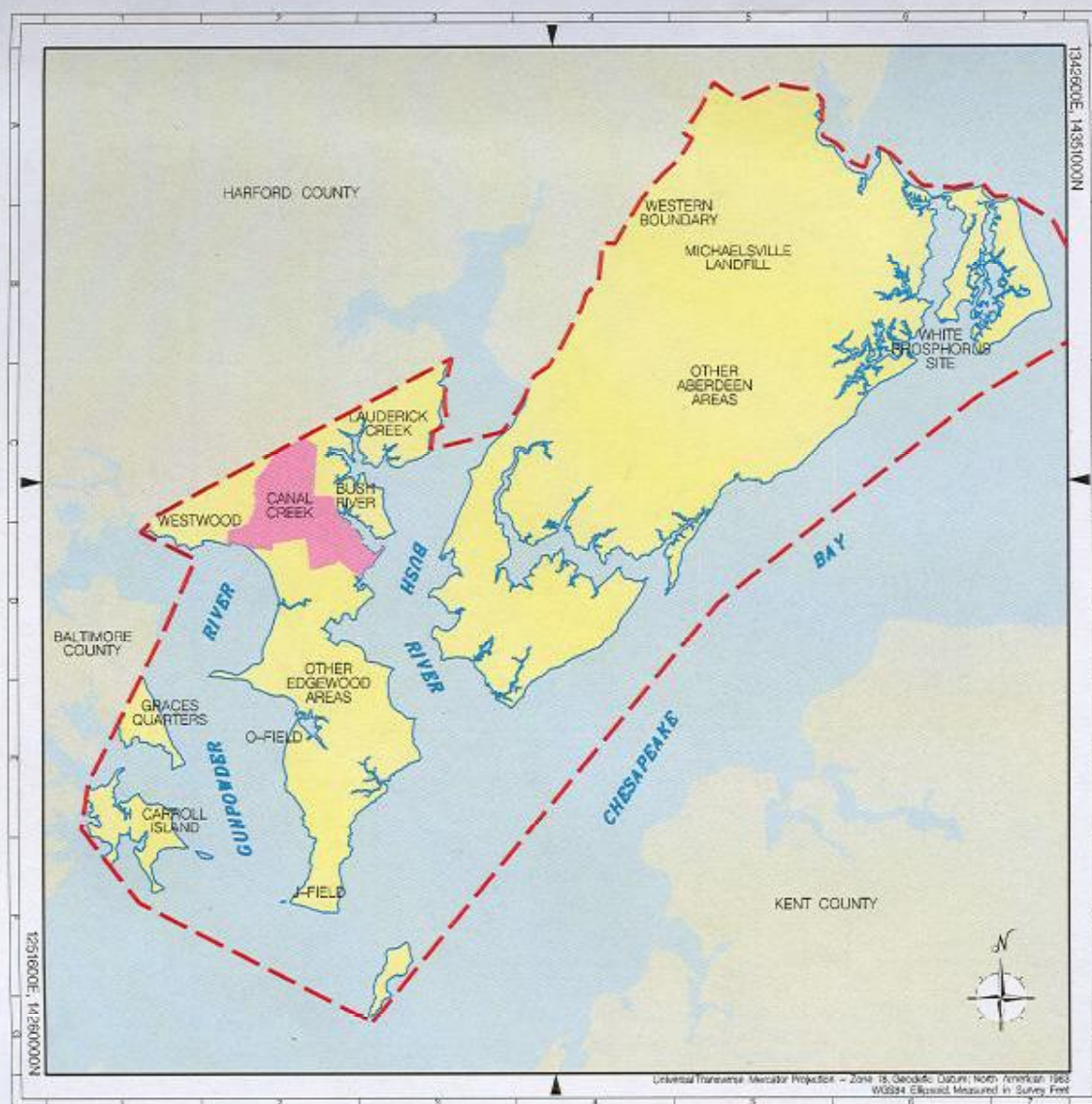
- Section 1 (Introduction) provides an overview of the regulatory requirements that govern the APG IRP and the RI process at the CCSA. It presents the purpose and scope of the CCSA RI and summarizes the site history, preliminary assessments, and site investigations (or equivalent studies) conducted at the CCSA. The introduction also describes the scoping documents that guide the conduct of the RI.
- Section 2 (RI/FS Program Summary) addresses the scope of activities performed as part of this RI. It discusses the specific rationale for all locations, procedures, and methods used for performing field activities, and protocols.

- Section 3 (Physical Characteristics) discusses the physical setting, including regional and local geology, hydrogeology, climate, demography, and ecology in the CCSA. This section also characterizes the surface soil, unsaturated zone, and aquifers based on the results of geologic and hydrogeologic studies.
- Section 4 (Nature and Extent of Contamination) assesses the nature and extent of media contamination, presents the approach to the analysis of the RI field investigation results, and summarizes RI sampling results at or above the RI comparison criteria.
- Section 5 (Contaminant Fate and Transport) evaluates the fate and transport of the sustained and patterned contaminant constituents, and their interaction with the environment at the CCSA.
- Section 6 (Baseline Risk Assessment) evaluates potential impacts to human health and ecological receptors in the CCSA. The risk assessment screens and identifies receptor pathways, and evaluates the level of risk associated with the contamination at the CCSA.
- Section 7 (Summary and Conclusions) summarizes the nature and extent of contamination at the CCSA based on RI sampling results and evaluation of potential human health and ecological risks.
- Section 8 (References) lists the references used in the preparation of this report.

1.3 Site Description

APG lies on the northwestern shore of the Chesapeake Bay in southern Harford County and southeastern Baltimore County, Maryland. Major geographical areas bordering APG include the Chesapeake Bay and its tributaries; Gunpowder Falls State Park; the Crane Power Plant; and the towns of Bel Air, Edgewood, Joppatowne/Magnolia, Aberdeen, and various smaller residential areas. The northern portion is referred to as the Aberdeen Area (AA) and encompasses approximately 27,500 acres of land. The southern portion is referred to as the Edgewood Area (EA) and encompasses approximately 9,700 acres of land, including the CCSA (Figure 1).

The CCSA, a 700-acre parcel located within APG-Edgewood Area (APG-EA), has been utilized since WWI for the development, testing, and manufacturing of military-related chemicals and agents. The CCSA is located within the northern portion of APG-EA, bordered by the Westwood Study Area on the west, Bush River and Lauderick Creek Study Areas on the east, and Other Edgewood Areas to the south. The location of CCSA within APG-EA is shown on Figure 1. The locations of the thirty-five CCSA sites addressed by the "Potential Source



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Definition Study” are highlighted on Figure 2. The KCIA sites are shown on Figures 6 and 7. [NOTE: The three remaining regions are shown on Figures 3, 4, and 5 – to-be-provided in the final combined RI Report.]

1.4 History

1.4.1 Installation History

Both the EA and AA of APG were established in 1917. Since 1917, the APG-EA has been the center for research, development, testing, and manufacture of military chemical agents and materials related to chemical warfare. Since the end of WWII, the chemical manufacturing activities were scaled down and many of the plants were abandoned or converted to pilot-scale chemical manufacturing facilities. Until the 1970s, most of the buildings in the CCSA discharged liquid wastes to the west or east branches of the Canal Creek. In September 1986, USEPA issued a Resource Conservation and Recovery Act (RCRA) Part B permit to APG. This permit required the assessment of Solid Waste Management Units (SWMUs) at APG due to their potential for release of contaminants to the environment. Studies performed within the guidelines of the RCRA permit identified the CCSA as one of the four areas that contained SWMUs. These studies included the Hydrogeologic Assessment conducted by US Geological Survey (USGS) (USGS, 1989) and the RCRA Facility Assessment (RFA) [US Army Environmental Hygiene Agency (USAEHA), 1989].

As a result of findings from several investigations, APG-EA was placed on the National Priorities List in February 1990. The Department of the Army and USEPA Region III entered into a FFA that subjects APG to RCRA corrective action and CERCLA remedial action requirements for the contaminated sites (USEPA Region III and US Army, 1990). The APG DSHE implements the IRP to fulfill the requirements of the FFA. The designations for sites under the purview of CERCLA and the IRP were later changed from SWMUs to DSERTS sites (and recently to AEDB-R sites). The FFA identified the CCSA as one of the areas requiring response actions in accordance with applicable regulations.

1.4.2 Site History

Site histories for the fifteen KCIA sites are provided below. Additional details are available in the RFA (USAEHA, 1989) and *Canal Creek Study Area Remedial Investigation Progress Report* [Jacobs Engineering Group, Inc. (JEG), 1995b].

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L E G E N D

- Road
- Stream (Blue Number)
- Forest Shrubline (Green Number)
- Water
- Wetland
- Trailway
- Cause Boundary

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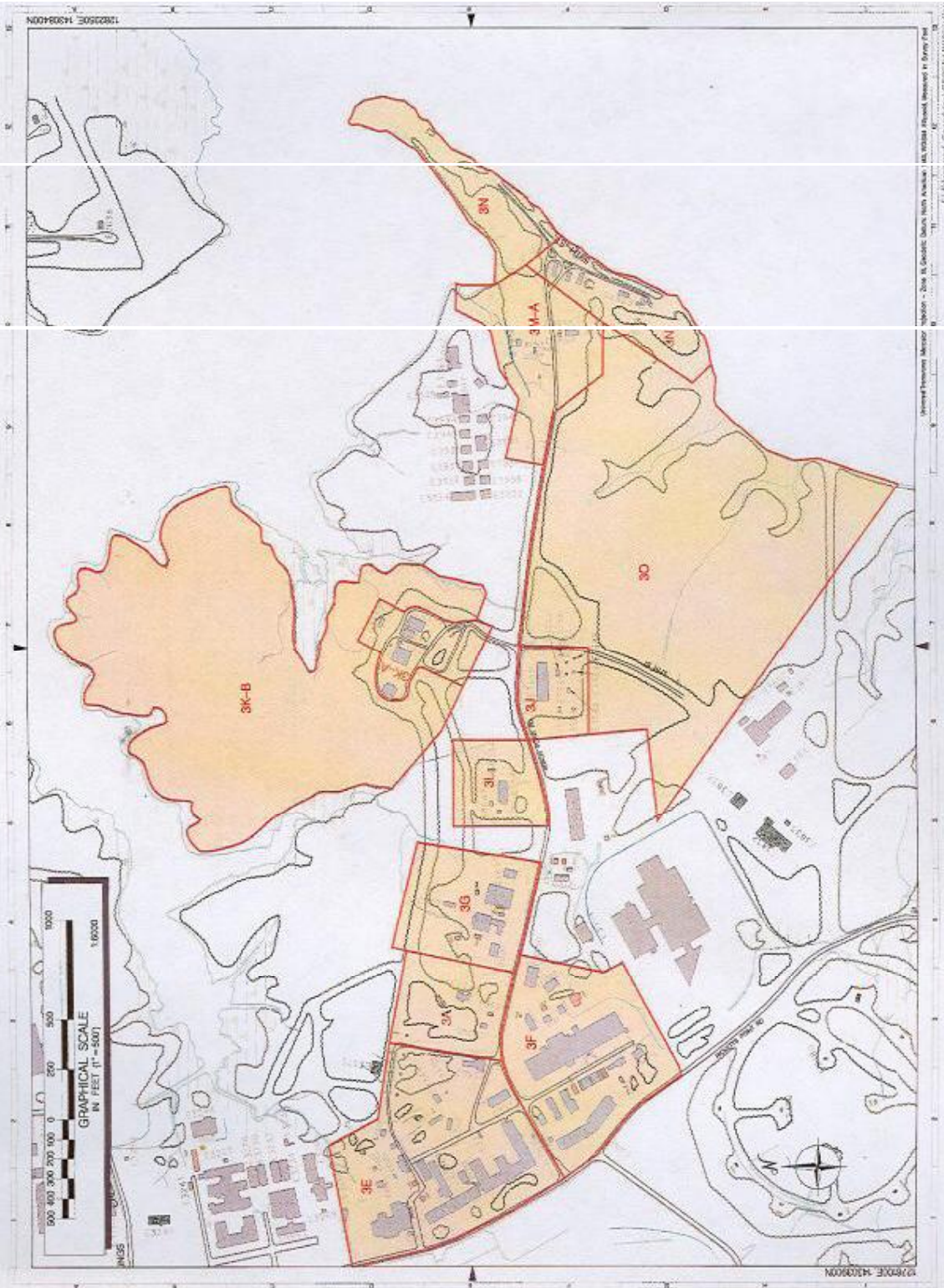


GIVEX CORPORATION
 TITLE

KINGS CREEK INDUSTRIAL AREA (SOUTH)

APPROVED BY
 B. JOYCE
 J. HARRIS
 DATE 03-24-00
 FIGURE

1 Kings Creek Industrial Area (South) Map



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EACC3A – Building E3330 Laboratory Toxic Waste Disposal Pit – Site EACC3A encompasses approximately 5.9 acres on the east side of Building E3370, north of Beach Point Road. Disposal activities occurred sometime during the 1943 to 1947 time period. The pit location is known only from memory of an individual who worked in the area and the exact location is unknown (USAEHA, 1989). It was described earlier as being approximately 6 feet (ft) by 12 ft in size, 6 ft deep, and containing several feet of water. Wastes included mustard, lewisite, chloropicrin, and contaminated laboratory equipment. It is not known if other pits also existed in this area but due to the short period of time involved, it is possible that only the one pit was used.

The suspected pit site is located on a drainage divide between Kings Creek on the north and Wright Creek to the southwest. Kings Creek is approximately 1,000 ft to the north-northeast and the Wright Creek marsh is about 2,000 ft to the southwest. The ground surface elevation at the site is slightly more than 30 ft above mean sea level (msl). Inspection of the site revealed a small area in which the vegetation type indicates wetter soil conditions (USAEHA, 1989). This may be due to a “bathtub” effect. The small area of distinct vegetation is 95 ft east-southeast of E3370 and 20 to 25 ft across. No recent removal actions have been documented for this site.

EACC3C – Building E32XX, E3100, E3081 Medical Research Laboratories – Site EACC3C is approximately 50.8 acres located along the east side of Ricketts Point Road, between the Family Housing Area and Building E3300. The site consists of Buildings E3081, E3100, and E32XX Medical Research Laboratories and surrounding areas. Buildings in this cluster were constructed during WWII over a former Fort Hoyle training site. A hospital complex (Building E31XX) originally occupied the site of Building E3100. In the 1960s, the hospital structures were demolished and the Building E3100 medical research laboratory was built in their place. Building E3081 was constructed in the 1970s as an additional medical research facility. The Building E32XX structures were originally used for medical research. Presently, they are used as chemistry research laboratories. Primary mission responsibilities at these facilities are research and development related to chemical warfare.

One research activity, aquatic toxicity testing, is performed in Building E3224. These tests required a source of clean water to support the aquatic life and therefore a well was installed for this purpose. An original well was installed to a depth of 140 ft and screened between 110 and 130 ft but was tested and found to be contaminated. The contamination was not described; however, the well was presumably screened in the Canal Creek Aquifer which is known to be contaminated in this area. A new well was constructed southwest of the corner of Building E3224 to a depth of 325 ft and screened in the lower confined aquifer.

Buildings E3081, E3100, and E32XX facilities were serviced by chemical and sanitary sewer systems. The chemical sewer discharge points are located in ditches and Kings Creek marsh